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I, JONNE YABSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PR 4625 for a patent by DES MASLEN filed on 27 April 2001.

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J R Yabsley

JONNE YABSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

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AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATIION

FOR THE INVENTION ENTITLED:

"RADIAL ENGINE"

The invention is described in the following statement:-

FIELD OF THE INVENTION

This invention relates to a radial engine. Although the invention is described as an internal combustion engine in which the pistons are configured to drive the crank, it will be appreciated that the invention is not limited to this particular application.

BACKGROUND

Unless the context clearly indicates otherwise, any discussion of the prior art in this specification is not intended to constitute, nor is it to be taken as, an admission that this prior art forms part of the common general knowledge.

There are various known radial engines. A radial engine generally has a crankshaft and pistons disposed in a radial relationship about the crankshaft. The pistons are disposed to engage the crankshaft such that there is correspondence between the rotation of the crankshaft and the reciprocating motion of the pistons in their cylinders.

In one known radial engines, the crankshaft is substituted by a crank which is configured to permit the pistons to be aligned with one another along the length of the rotational axis of the crank. As the pistons are aligned, the normal stepped-waveform crankshaft configuration cannot be used. Usually this is substituted by a cam-and-follower arrangement to permit a translation between the linear, reciprocating motion of the pistons and the rotational motion of the crank. It will be appreciated that, due to the alignment of the pistons, this arrangement provides a significantly greater degree of compactness than in the case of engines where the pistons are positioned at spaced intervals along the length of the crankshaft.

However, due to the usual cam-and-follower arrangements, such radial engines have disadvantages relating to the reaction forces exerted by the cranks on the pistons, via the followers and connecting rods. Further disadvantages relate to the methods adopted for effecting suitable engagement between the followers and the cranks. For

example, certain of these engines have required cranks with particularly complex structures and complex means for providing lateral support to the connecting rods. Such structures are expensive and difficult to produce and hence are often not suitable for large-scale production.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome or ameliorate one or more of the disadvantages of the prior art, or to provide a useful alternative.

Therefore, according to the invention there is provided a radial engine including:

a crank supported for rotation about a crank axis and defining a pair of elongate continuous walls which are in an opposed relationship to each other, the continuous walls extending around, and facing substantially perpendicularly to, the crank axis at each position along their respective lengths;

cylinders disposed radially about the crank axis adjacent the crank;

a respective piston in each cylinder, each piston being reciprocatable within the cylinder along a straight piston axis which extends perpendicularly to the crank axis;

connecting rods each having one end joined to a respective piston, an opposite free end, and a cam follower disposed adjacent the free end each cam follower being disposed to move in cam engagement with at least one of the continuous walls whereby there is correspondence between rotation of the crank about the crank axis and reciprocation of each of the pistons.

In one preferred embodiment, the walls face each other to define a continuous slot between them, the slot having a mouth facing substantially parallel to the crank axis, and each cam follower projects through the mouth into the slot and is disposed to move along the slot.

In another preferred embodiment, the crank includes a protruding continuous ledge formation having opposed side-walls constituted by said continuous walls, with an intervening wall interconnecting said continuous walls, and each cam follower defines a channel through which the ledge formation extends, the followers being configured to move along the ledge formation as it passes through the channels.

In a preferred embodiment, each cam follower includes a shoe for effecting engagement of the follower with, and guiding the follower along, at least one of said continuous walls.

In another embodiment, each cam follower includes a roller for rolling engagement with at least one of the continuous walls.

Preferably, the engine is configured for reciprocation of the pistons to rotate the crank about the crank axis.

Preferably, the engine includes a cylindrical shaft on which the crank is mounted for rotation about the crank axis.

In one embodiment, the piston axes intersect the crank axis.

Preferably, each connecting rod is angularly fixed with respect to the piston axis of the respective piston.

The engine preferably includes guides for guiding the connecting rods. Preferably, the engine includes an engine block and the guides are constituted by passages in the engine block for accommodating the connecting rods during reciprocation of the pistons, the passages having sidewalls for laterally supporting the connecting rods.

Preferably, each cam follower is constituted by a pin formation having a free pin-end projecting through the mouth into the slot. In one preferred embodiment, each

follower is constituted by a pin and each rod has an aperture adjacent the free end, the pin being located in the aperture.

Preferably, each sidewall defines an elongate gap extending along the respective passage, the pin-ends projecting through the gaps, into the slot.

In a preferred embodiment, the crank includes two crank parts each defining a said slot, the crank parts being disposed to face each other with the slots being a mirror-image of each other. Preferably, the crank parts are spaced by a spacer. Preferably, the crank parts are located to each other by locating pins.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention will now be described by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a side elevation of an engine according to an embodiment of the present invention;

Figure 2 is an elevation of the engine of Figure 1 in the direction of arrow II;

Figure 3 is a side elevation of an engine block of the engine of Figure 1;

Figure 4 is an elevation of the block of Figure 3 in the direction of arrow IV;

Figure 5 is a side elevation of an engine block cover forming part of the engine of Figure 1;

Figure 6 is an elevation of the cover of Figure 5 in the direction of arrow VI;

Figure 7 is a side elevation of a further engine block cover forming part of the engine of Figure 1;

Figure 8 is an elevation of the cover of Figure 7 in the direction of arrow VIII;

Figure 9 is a side elevation of part of a crank forming part of the engine of Figure 1;

Figure 10 is an elevation of the part of Figure 9 in the direction of arrow X; and

Figures 11 and 12, 13 and 14, 15 and 16, and 17 and 18, are side elevations and end elevations, respectively, of various components of the engine of Figure 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawings, the engine 1 has an engine block 2 with a circular recess 3 on each side of the block, and a web 4 dividing the recesses. A crank 5, having two crank parts 6 and 7, is supported on a cylindrical shaft 8 (see especially Figures 11 and 12) for rotation about a crank axis 9. Each crank part 6 and 7 is accommodated in a respective one of the recesses 3. There is a plurality of cylinders 10 disposed radially with respect to the crank axis 9, about the engine block 2. The crank parts 6 and 7 are substantially enclosed within the recesses 3 by a pair of engine block covers 11 and 12. The engine block 2 and the covers 11 and 12 are held together by means of Allen screws 13 passing through holes 14 in the covers and block. The skilled addressee will appreciate that the parts of the engine described above may be of various materials, including, where appropriate, brass, steel, or aluminium. Furthermore, the parts may, as appropriate, be cast or machined. The cylinders 10, in one embodiment, are bolted to the engine block 2, although in other embodiments the cylinders may be cast or machined to be integral with the engine block.

The engine block 2 has a circular central aperture 15. A plurality of passages 16 of generally circular cross-section extend radially from the outer rim 17 of the engine block 2 to the central aperture 15. The passages 16 have sidewalls 18, although, as the diameter of the cross-section of the passages is greater than the thickness of the web 4, the sidewalls have gaps 19 which open through the opposite outer surfaces of the web.

The shaft 8 has a cylindrical broad shaft-portion 20 and a cylindrical narrow shaft-portion 21. The narrow shaft-portion 21 is of smaller diameter than the broad shaft-portion 20 so that there is a shoulder 22 between the portions. The narrow shaft-

portion 21 includes a radially outer screw thread 23 which extends from a free end 24 of the narrow shaft-portion towards a position closer to the shoulder 22.

The crank parts 6 and 7 are substantially in the form of plates which are disposed so as to face each other with the web 4 between them. The crank parts 6 and 7 are spaced from each other by a spacer 25 (see especially Figures 15 and 16) which extends through the central aperture 15 of the engine block 2, and they are fixed in their relative position by locating pins 26 (see Figures 17 and 18).

Each crank part defines a pair of continuous walls 27 (see Figure 9) which, in turn, define between them a continuous slot 28, the walls and slot extending around the crank axis 9. It will be appreciated that the walls 27, at any position along their lengths, face perpendicularly to the crank axis, as indicated by the arrows 29. Similarly, it will be appreciated that the mouths 30 of the slots, defined by the walls, face substantially parallel to the crank axis, as indicated by the arrow 31.

The slots 28 of the two crank parts 6 and 7 are configured to be mirror images of each other. Therefore, because the crank parts 6 and 7 are disposed to face each other, the slots 28 are fully aligned and co-extensive with each other.

A locking element 32 (see especially Figures 13 and 14), having a spigot-shaped portion 33 and a nut 34, is screwed onto the screw-threaded end 23 of the narrow shaft portion 21. The nut 34 is secured against the crank 5 to hold the crank captive against the shoulder 22. In one embodiment, the crank parts 6 and 7 are constrained to rotate with the shaft 8 by means of a key and keyway (not shown). In another embodiment, this is achieved by means of splines (also not shown).

The engine block cover 12 has a socket-shaped portion 35 which defines a central aperture 36 through which the broad shaft-portion 8 extends as a running fit.

The other engine block cover 11 has a stepped-socket-shaped portion 37 which has a larger-diameter part 38 and a smaller-diameter part 39. The larger-diameter part 38 accommodates the nut 34 of the locking element 32. The smaller-diameter part 39 defines a central aperture 40 through which the spigot-shaped portion 33 of the locking element 32 extends as a running fit.

It will be appreciated that rotation of the crank 5 about the crank axis 9 is enabled by the running fits of the spigot-shaped portion 33 of the locking element 32 and the broad shaft-portion 8 in the apertures 40 and 36, respectively. In a further embodiment (not shown) the spigot-shaped portion 33 and the broad shaft-portion 8 may be provided with bearings to facilitate rotation of the crank 5. Furthermore, seals (not shown) may be provided to retain lubricant at positions where one surface rotates on another.

In each cylinder 10 there is disposed a piston 41 which is reciprocatably movable within the cylinder along a respective straight piston axis 42. Each piston axis 42 is perpendicular to, and intersects, the crank axis 9. One side of each piston 41 forms part 43 of a combustion chamber. On the other side of each piston 41, there is attached one end 44 of a connecting rod 45. The connecting rods 45 extend along the passages 16 and are therefore laterally supported by the sidewalls 18. It will therefore be understood that the connecting rods 45 are angularly immovable relative to the respective piston axes 42.

Each connecting rod 45 has an opposite free end 46 and an aperture 47 adjacent the free end. A respective cam follower in the form of a pin 48, is located in each aperture 47. Each pin 48 has opposite free ends and a central portion between the ends. It is the central portion of each pin which is located in the apertures. The free ends of the pins project through the gaps 19 and through the mouths 30 into the slots 28.

In use, each piston 41 is powered in a manner conventionally employed in internal combustion engines (although the cylinder heads and the intake and exhaust

valves and/or ports are not shown in the drawings). The resulting reciprocating motion of the pistons 41 along their respective piston axes 42 involves corresponding motion of the connecting rods 45. It should be noted that the gaps 19 extend substantially parallel to the respective piston axes 42. Thus, when the pistons 41 reciprocate, the free ends of the cam-follower pins 48 slide along the gaps 19, while engaging with the walls 27. In the present, preferred embodiment, each pin 48 has a shoe at each of its free ends for engaging, and guiding the pin along, the walls 27. However, in another embodiment (not shown) each pin 48 is equipped with a roller for rolling along the walls 27.

The timing of the piston movement and the specific configuration of the slots 28 are such that the pistons 41, via the connecting rods 45, drive the crank 5 in rotation about the crank axis 9, with the walls 27 acting as cam surfaces in engagement with the cam followers pins 48.

In a different embodiment of the invention (not shown) the crank includes a protruding continuous ledge formation having opposed side-walls, with an intervening wall interconnecting these opposed walls. In this embodiment, each cam follower defines a channel through which the ledge formation extends. The followers are configured to move along the ledge formation while it passes through the channels, during rotation of the crank.

The configuration of the engine 1 is such that it is suitable for use as a two-stroke engine or a four-stroke engine.

Because the connecting rods 45 are guided in the passages 18, the lateral reaction forces exerted by the crank 5 on the cam-follower pins 48 is not communicated to the pistons 41. Accordingly there is no specific requirement for the pistons 41 to be capable of withstanding bending moments which may result in conventional engines. Therefore,

the piston skirts present in conventional engines can be reduced in length or omitted entirely, as in the embodiment being described.

Where the engine 1 is used as the type of two-stroke engine where the fuel-air mixture is drawn into the area below the piston, because the connecting rods do not move from side-to-side as in a conventional two-stroke engine, and because of the shorter or omitted skirts, a greater degree of compression can occur on the fuel-air mixture below the piston. Without wishing to be bound by theory, the applicant believes that, where a compression to 6 psi might be achieved in the case of a conventional two-stroke engine, a compression to 150 psi is achievable using an engine in accordance with an embodiment of the present invention.

Generally, if the exhaust port was lowered in a two-stroke engine of the type being discussed, this would be advantageous in one sense, as it would prolong the power stroke, with a resulting increased torque. However, in another sense, it would be disadvantageous as it would delay the evacuating of exhaust gases which would, in turn, reduce the ability to transfer fuel-air mixture from below the piston to the combustion chamber. This effect would be particularly significant in cases where high engine revolution rates were required. The greater compression permitted by an engine according to an embodiment of the present invention would, however, increase the potential rate of transfer of fuel-air mixture from the area below the piston to the combustion chamber. As the resulting forcing of fuel-air mixture into the combustion chamber would also force the burnt gases out through the exhaust port, the effect of delaying the exhausting of spent gases would be offset. Accordingly, embodiments of the present invention lend themselves to lowering the ports, with the associated advantage of longer power strokes and higher torque, without the disadvantage of reduced rate of transfer of gases.

In addition to the above, the shorter or omitted skirts would result in the pistons being lighter than those in conventional engines. The use of lighter pistons in conjunction with the radial configuration would reduce or eliminate the need for counter-weights or crankshaft bob weights which may be required in conventional engines to achieve suitable balancing. The lighter pistons would also reduce stresses, and the power losses associated with overcoming inertia.

A further advantage of the arrangement envisaged by the present invention is that the slots 28 could be configured for each piston 41 to reach top dead centre twice for every single revolution of the crank 5 and hence of the output shaft 8. This may permit greater compactness as the stroke would effectively be doubled without increasing the physical size of the engine.

It will be appreciated that the features of the present invention, at least in preferred embodiments, provide an effective way of achieving the cam-and-follower structure required for a radial engine of the present type. Notable among these features are the opposed walls 27 which form an integral part of the crank 5, the slots 28 defined by these walls, the passages 18 in the engine block 2 and the gaps 19 in the sidewalls 18 through which the cam follower pins 48 extend. These features provide a relatively simple balance between, on the one hand, the desired conversion from translational motion of the pistons 41 to rotational motion of the crank 5 with the pistons being aligned with one another for compactness, and, on the other hand, effective lateral support of the connecting rods 45 and minimisation of bending moments on the pistons.

An advantage of the engine according to an embodiment of the invention is that the cylinders are arranged in opposed pairs and therefore provide for a natural balancing of the engine. It will be appreciated that, although 8 cylinders are shown in the described example, other multiples of two cylinders can be used instead.

The invention is described above as an internal combustion engine in which the pistons are configured to drive the crank. However, it will be appreciated that the invention is not limited to this particular application. For example, the engine may be configured so that the crank is driven by a prime mover, with the crank, in turn, driving the pistons in their reciprocating motion. Such a construction may constitute, for example, a pump apparatus, with the pistons constituting individual pumps.

Although the invention has been described with reference to a specific embodiment it will be appreciated by those skilled in the art that it may be embodied in many other forms.

DATED this 27th day of April, 2001

DES MASLEN

Attorney: STUART M. SMITH
Fellow Institute of Patent Attorneys of Australia
of BALDWIN SHELSTON WATERS

Fig 1

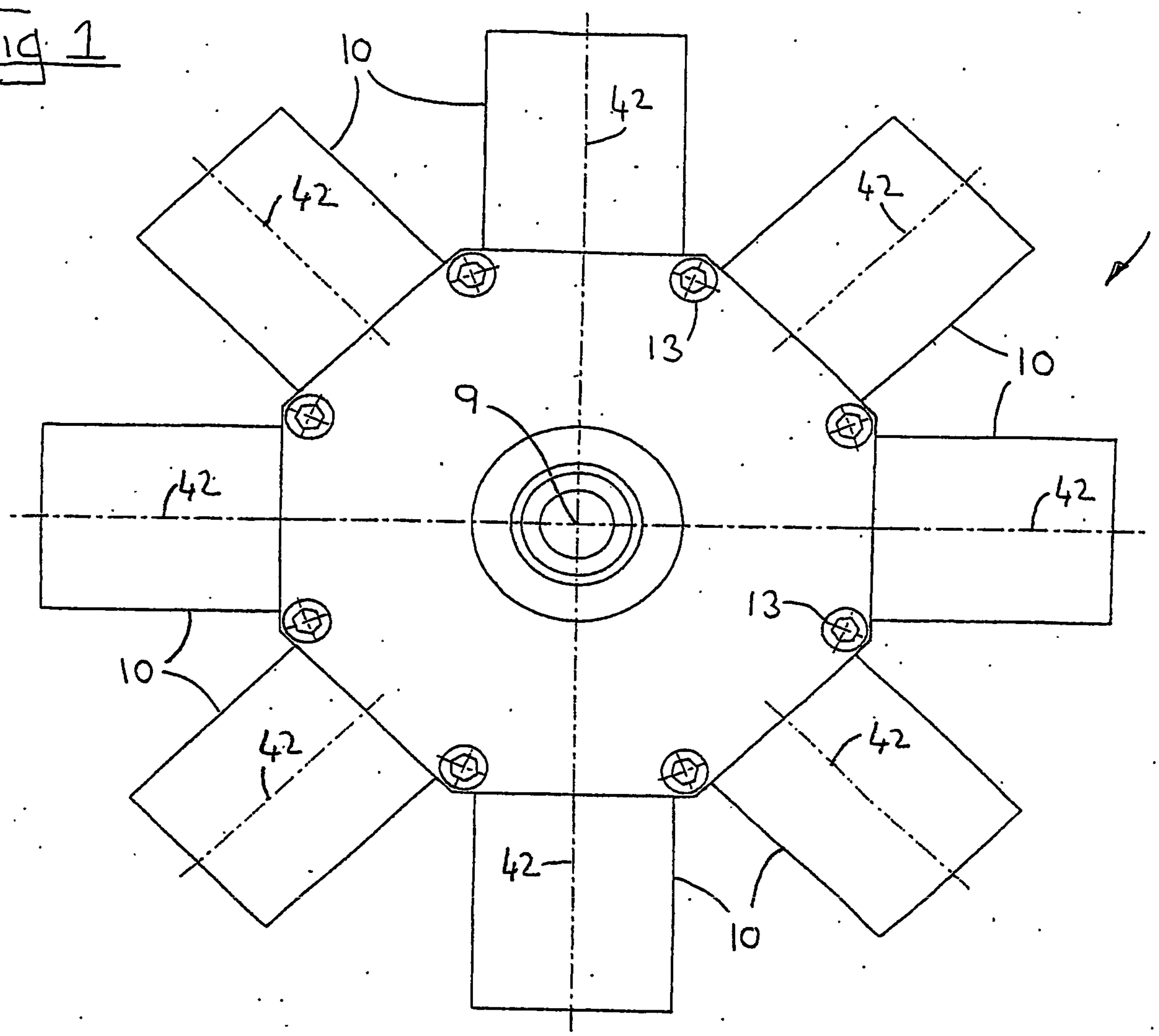

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Fig 2

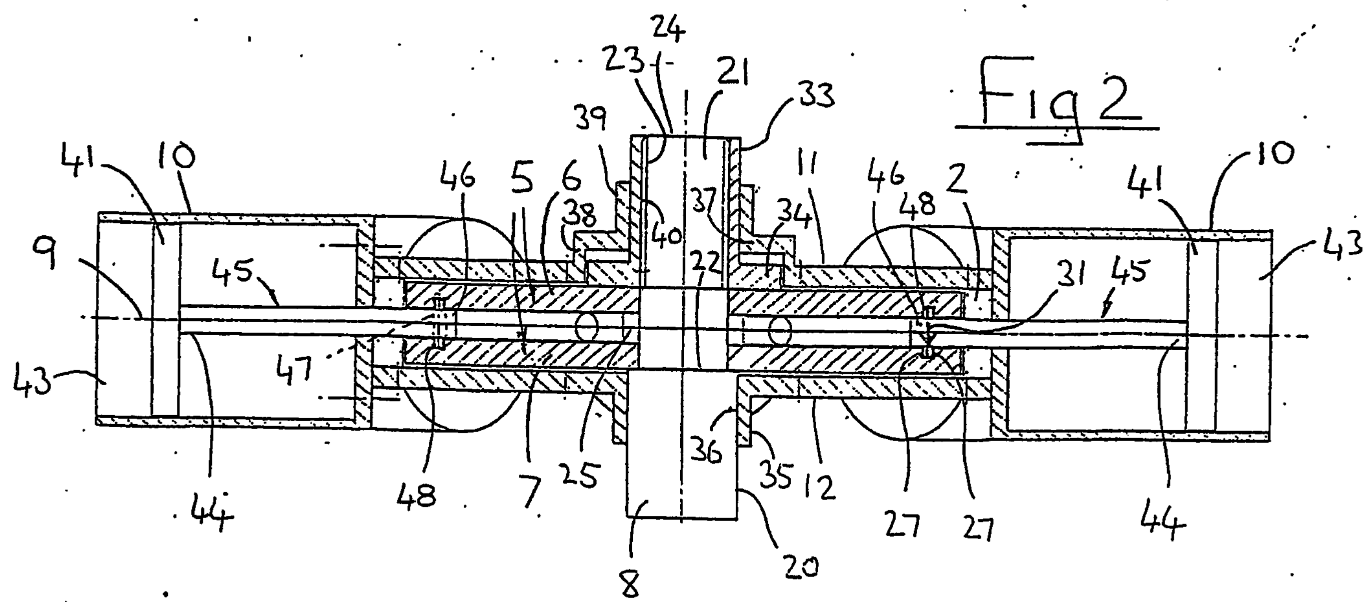

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Fig 3

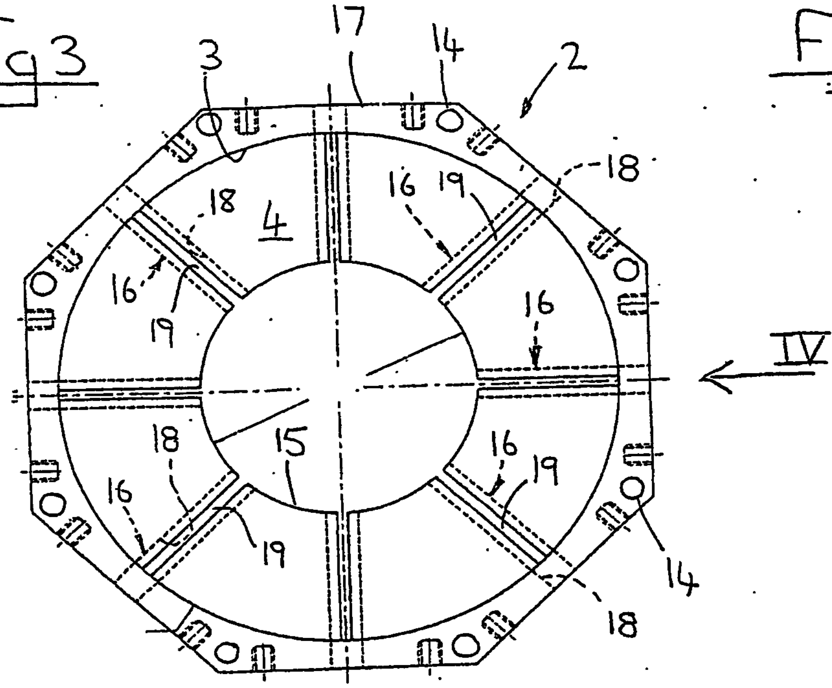

Fig 4

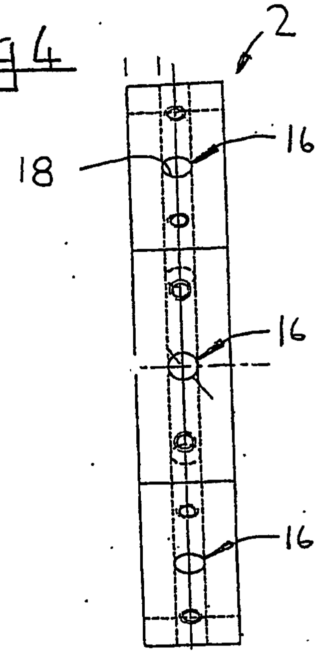

Fig 5

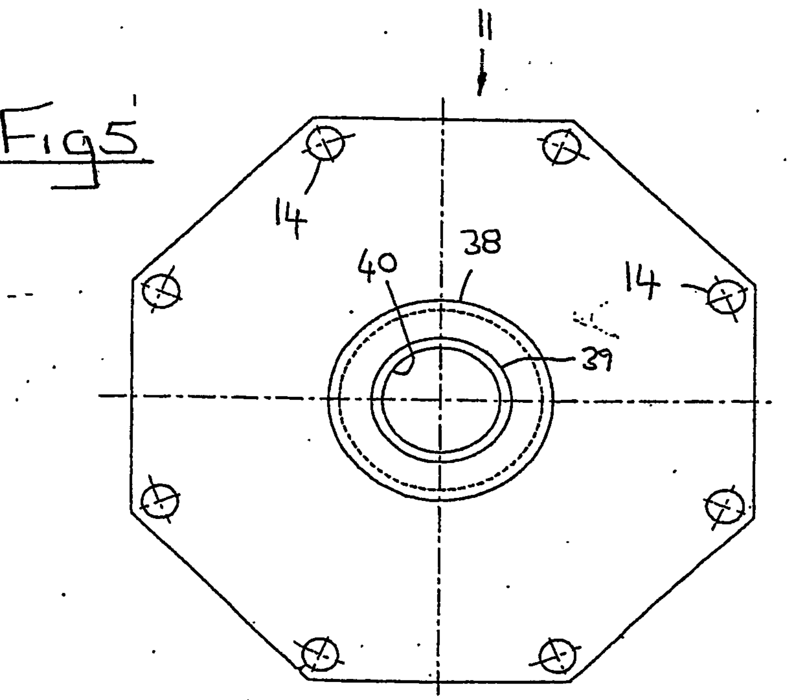

Fig 6

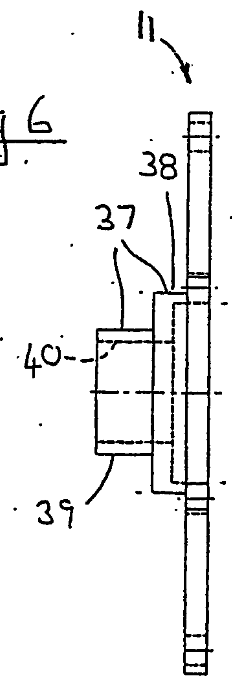

Fig 7

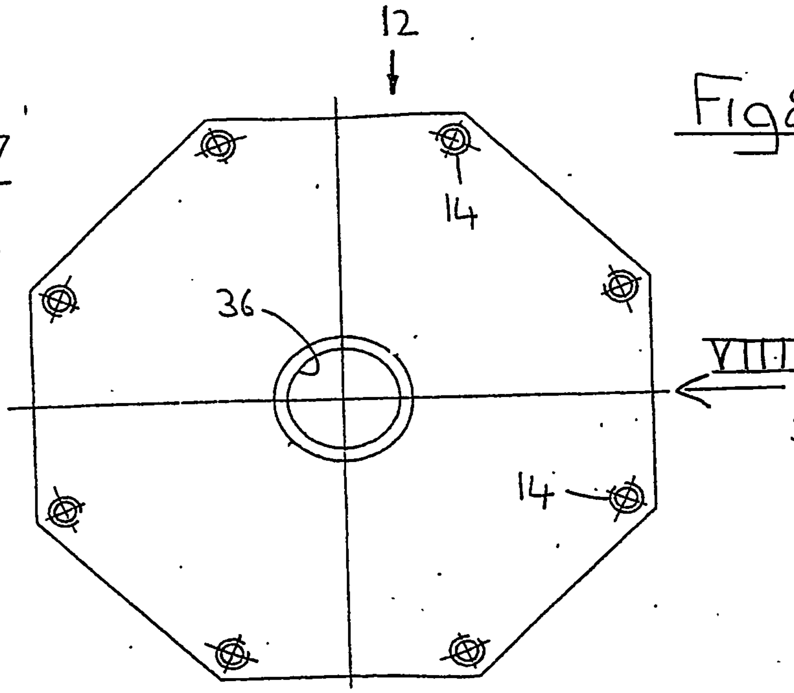

Fig 8

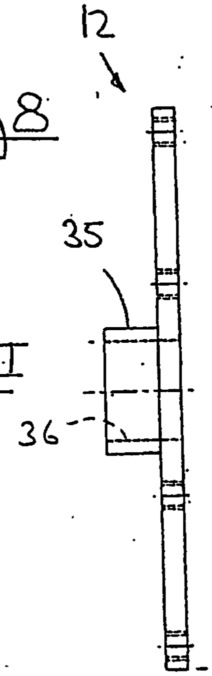

Fig 9

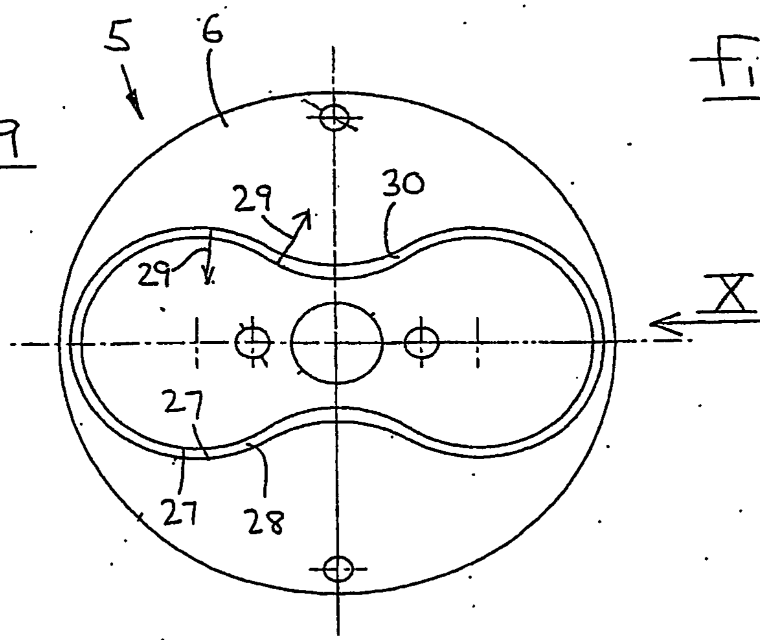

Fig 10

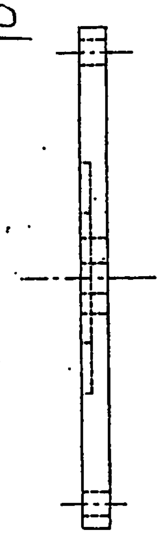

Fig 11

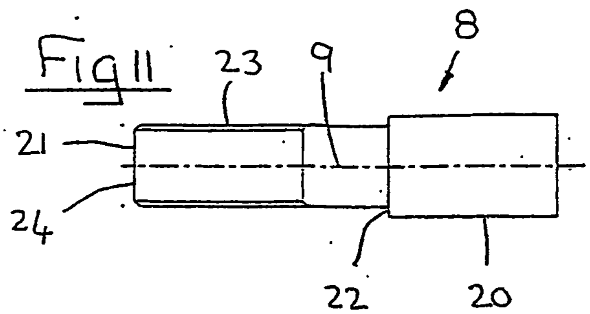

Fig 12

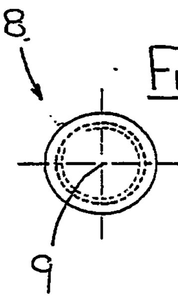

Fig 13

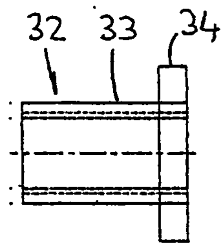

Fig 14

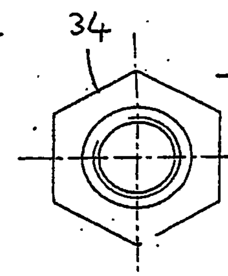

Fig 16

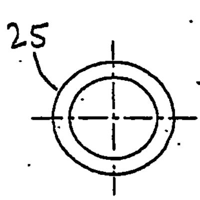

Fig 17

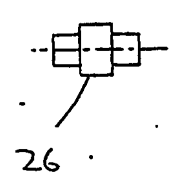

Fig 18

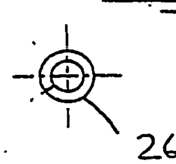

Fig 15